Acute Haematogenous Osteomyelitis
What are we discussing?
Osteomyelitis
Definitions

- Osteomyelitis: Inflammation of bone caused by pyogenic organisms

**Scheme that applies irrespective of the underlying source of the offending bacterium**

- Acute Osteomyelitis: Infection diagnosed ≤ 2/52 after the onset of symptoms
- Subacute Osteomyelitis: Infection diagnosed > 2/52 after the onset of symptoms
- Chronic Osteomyelitis: Infection diagnosed months after the onset of symptoms with hallmark findings of dead and reactive bone

NO SCIENTIFIC RATIONALE FOR TIME FRAMES

? Virulence properties of infective strain?

Nada S, Smeltzer M. Management of acute haematogenous osteomyelitis in children
Osteomyelitis
Definitions

Scheme that applies to the underlying source of the offending bacterium

- **Acute Haematogenous Osteomyelitis**: Infection diagnosed ≤ 2/52 after the onset of symptoms arising from hematogenous seeding from the endosteal blood supply
- **Acute Osteomyelitis secondary to a contiguous focus of infection and/or vascular insufficiency**

Nada S, Smeltzer M. Management of acute haematogenous osteomyelitis in children
Acute Haematogenous Osteomyelitis Diagnosis
Acute Haematogenous Osteomyelitis Diagnoses

- No definitive guidelines for diagnosis
- Recommendations in the literature based on expert opinions, case series and cohort studies.
- Difficult to standardize diagnosis
- Avoid “Cookbook” approach

Acute Haematogenous Osteomyelitis Diagnoses

- Clinical Manifestations
- Standard Radiography
- Laboratory Tests
- Further Imaging
Acute Haematogenous Osteomyelitis
Diagnosis-Clinical Manifestations

Presenting Features
Skeletal Distribution
Risk Factors
Red Flags

Nada S, Smeltzer M. Management of acute haematogenous osteomyelitis in children
## Acute Haematogenous Osteomyelitis

### Presenting Features

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>81.1</td>
</tr>
<tr>
<td>Localized signs/symptoms</td>
<td>70.0</td>
</tr>
<tr>
<td>Fever</td>
<td>61.7</td>
</tr>
<tr>
<td>Reduced ROM</td>
<td>50.3</td>
</tr>
<tr>
<td>Reduced Weight-bearing</td>
<td>49.3</td>
</tr>
</tbody>
</table>

- **Pain:** Constant and Progressive
- **Localized:** Older > Young Children > Metaphysis
- **Fever:** Typically abrupt and > 38°C
- **Moderate reduction in ROM**
- **Pseudo-paralysis or Reduced Weight-bearing**
- **Redness, Warmth, Swelling once progression through metaphyseal cortex into subperiosteal space**
- **Less Common:** Anorexia, Irritability, Lethargy

---


Herring J, Infections of the Musculoskeletal System, Tachdjian’s Pediatric Orthopaedics. 2014
Acute Haematogenous Osteomyelitis
Skeletal Distribution

Pelvis
- Average of 12 days before diagnosis
- Frequently masked by A/B
- Infective DDx in and around the hip in children:
  - Septic Arthritis
  - Iliac Crest Osteitis
  - Psoas Abscess

Clavicle (1%)
Spine (4%)
Hand (2%)
Humerus (8%)
Forearm (5%)
Femur (27%)
Calcaneum (5%)
Tibia (26%)

Pelvis (9%)

### Acute Haematogenous Osteomyelitis Risk Factors

<table>
<thead>
<tr>
<th>? Who are more at RISK?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unknown</strong></td>
</tr>
<tr>
<td><strong>Developing Countries</strong></td>
</tr>
<tr>
<td><strong>Children &lt; 3 Years</strong></td>
</tr>
<tr>
<td><strong>Blunt Trauma</strong></td>
</tr>
<tr>
<td><strong>Recent Systemic Infection</strong></td>
</tr>
<tr>
<td><strong>Sickle Cell Disease</strong></td>
</tr>
</tbody>
</table>

## Acute Haematogenous Osteomyelitis

### Red Flags

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Presenting Features</th>
<th>Skeletal Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presumed Trauma or Injury</td>
<td>Emperic Antibiotics</td>
<td>Young Children</td>
</tr>
<tr>
<td>Pelvic Osteomyelitis</td>
<td>Concurrent Septic Arthritis</td>
<td>Acute Lymphoblastic Leukemia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multiple Sites</td>
</tr>
</tbody>
</table>
Acute Haematogenous Osteomyelitis

Plain Radiography

- Obvious changes (Osteopenia & Osteolytic Lesions) may not occur until 10-14 days after onset of Symptoms
- In isolation poor diagnostic sensitivity during first 10 days
- Essential to exclude other pathology
Acute Haematogenous Osteomyelitis
Plain Radiography

- Soft Tissue Oedema & Loss Facial Planes
- Adherent Joint Effusions
- Osteopenia
- Osteolytic Lesions
- Periosteal Elevation
- Cortical disruption

Acute Haematogenous Osteomyelitis
Plain Radiography
Acute Haematogenous Osteomyelitis
Plain Radiography

Osteomyelitis

Ewings Sarcoma
Acute Haematogenous Osteomyelitis
Laboratory Tests

FBC & Diff.
CRP
ESR
Culture

Acute Haematogenous Osteomyelitis

Laboratory Tests

Complete Blood Count with Differential

- WCC only elevated in 25-35% of children with AHO
- WCC > 12000 cells/ml
- Allows for assessment of all three marrow cell lines
- Useful to assess for unusual/particularly virulent organism OR Concurrent Septic Arthritis

Herring J, Infections of the Musculoskeletal System, Tachdjians’s Pediatric Orthopaedics. 2014
Acute Haematogenous Osteomyelitis Laboratory Tests

**Erythrocyte Sedimentation Rate**
- Rate at which red blood cells fall through plasma as measured in ml
- 91% Abnormal on presentation
- Peak 3-5 days
- Normalise in 3-4 weeks with effective treatment
- Non-Specific diagnostic indicator

**Erythrocyte Sedimentation Rate**
- Significant correlation between an ESR > 55ml/h and the presence of an abscess in pelvic osteomyelitis
- No periosteal abscesses or pyomyositis with ESR < 22ml/hr

Acute Haematogenous Osteomyelitis

Laboratory Tests

C-Reactive Protein

- Acute-Phase reactant
- 80.5% abnormal on presentation but 100% abnormal with concurrent septic arthritis
- Increase 1000 fold within 6 hours
- Peak 36-50 hrs
- Normalise within 1 week with effective treatment
- Most sensitive and reliable laboratory test for detecting acute inflammatory reactions

C-Reactive Protein

- CRP < 5 mg/dl effectively rules out serious bacterial infection
- CRP > 30 mg/l significantly associated with subperiosteal abcess formation and pyomyositis
- CRP > 1,5 admission levels on day 3 6.5 times more likely to have concurrent septic arthritis
- Significantly influenced by MRSA

Herring J, Infections of the Musculoskeletal System, Tachdjians’s Pediatric Orthopaedics. 2014
Acute Haematogenous Osteomyelitis Laboratory Tests

Local Tissue and Blood Cultures

Isolation of the causative organism remains the diagnostic gold standard and it is currently the only way to establish a definitive microbiologic diagnosis.

BLOOD CULTURE & NEEDLE ASPIRATION
Acute Haematogenous Osteomyelitis

Laboratory Tests

Blood Culture
- Should always be performed pre administration of Antibiotics
- Organism is recovered in approximately 50% of all AHO infections

Needle Aspiration
- A relatively non invasive procedures in neonates and young children
  ➢ Aspirate subperiosteal collection
  ➢ Metaphyseal bone aspiration
- Older children and adolescents often require more invasive surgical techniques such as drilling or cutting into the bone
- Direct inoculation of cultured material into a blood culture bottle increases the probability of recovering a fastidious organism such as K. kingae.
- Using PCR to identify pathogens from bone specimens is also increasingly common

Acute Haematogenous Osteomyelitis
Diagnosis- Further Imaging

Nada S, Smeltzer M. Management of acute haematogenous osteomyelitis in children
Acute Haematogenous Osteomyelitis
Further Imaging

Unsure Diagnosis
Complex Anatomical Location
Satellite Septic Foci
Treatment Guideline

Herring J, Infections of the Musculoskeletal System, Tachdjians’s Pediatric Orthopaedics. 2014
Acute Haematogenous Osteomyelitis
Further Imaging

Ultrasound

• ? Second step in diagnostic pathway ?
• Indications:
  ➢ Diagnosis if X-rays normal
  ➢ Abcess Formation
  ➢ ? Concurrent Septic Arthritis
  ➢ Ultrasound guided aspiration for culture
Acute Haematogenous Osteomyelitis
Diagnosis-Further Imaging

Bone Scintigraphy
- Technetium Methylene diphosphonate
- Three Phase bone scan:
  - Blood Flow phase
  - Blood Pool or Soft Tissue phase
  - Delayed or Skeletal phase
    Diagnostic for Osteomyelitis
- Focally increased uptake in all three phases of the study
- “Cold” or Photopenic in the delayed images

Bone Scintigraphy
- Most common indications:
  - Unable to localize site of infection
  - Multifocal involvement in Neonates
- Sensitivity: 54-100 %
- Specificity: 70-90 %
- Overall Accuracy: 90%

Herring J, Infections of the Musculoskeletal System, Tachdjians’s Pediatric Orthopaedics. 2014
Acute Haematogenous Osteomyelitis
Diagnosis-Further Imaging

MRI
Bone Scan
Ultrasound

Acute Haematogenous Osteomyelitis Diagnosis-Further Imaging

Magnetic Resonance Imaging
- Most powerful technique available
- Define definitive diagnosis
- Guide treatment decisions
- Disadvantages:
  - Cost
  - Lack of immediate availability
  - Sedation required in children

Magnetic Resonance Imaging
- Sensitivity: 80-100 %
- Specificity: 70-100 %

Herring J, Infections of the Musculoskeletal System, Tachdjian’s Pediatric Orthopaedics. 2014
Acute Haematogenous Osteomyelitis Diagnosis—Further Imaging

Decreased marrow signal intensity on T1-weighted images

Increased marrow signal intensity on T2-weighted images

Short-tau inversion recover images (STIR)

Marrow signal enhancement on post gadolinium T2-weighted images

Herring J, Infections of the Musculoskeletal System, Tachdjians’s Pediatric Orthopaedics. 2014
Acute Haematogenous Osteomyelitis Diagnosis - What does the future hold?

**Laboratory Investigations**
- Polymerase Chain Reaction
  - More Sensitive
  - Quicker Diagnosis
- Serum Procalcitonin
  - Differentiate between viral, bacterial and inflammatory process
  - More effective than CRP, ESR and WCC to differentiate between Septic Arthritis and Osteomyelitis

**Imaging**
- Positron emission tomography with computed tomography (PET-CT)
  - Superior to MRI
  - Limited availability
  - Radiation

Herring J, Infections of the Musculoskeletal System, Tachdjian's Pediatric Orthopaedics. 2014
Acute Haematogenous Osteomyelitis Diagnostic Flow Diagram

Clinical Suspicion
  ↓
  Perform:
  Radiographs
  Laboratory: WCC, ESR, CRP, Culture

? Abnormal Radiographs?
  ↓
  Yes
  No → Raised WCC, CRP > 10, ESR > 22

Yes
  ↓
  Clinical Diagnosis AHO
  ↓
  Yes
  No → Consider other Dx
  or
  Treatment

No
  ↓
  Select Further Imaging

↓
↓
Acute Haematogenous Osteomyelitis Diagnostic Flow Diagram

Select Further Imaging
If
Unsure Diagnosis / Treatment Guidance / Complex Anatomical Location / Satellite Lesions

MRI

Bone Scan

Ultrasound

Diagnostic?

YES
Diagnosis Confirmed
Initiate Treatment Protocol

NO
Consider Other Diagnoses

Acute Haematogenous Osteomyelitis: Prognosis
Acute Haematogenous Osteomyelitis
Prognosis

• **Pre Antibiotics ERA**
  - Serious disease with high morbidity and mortality

• **Antibiotic Sensitive ERA**
  - Improved diagnostics and treatment modalities
  - Morbidity significantly decreased
  - Mortality negligible in the developed world

• **Post Antibiotics ERA**
  - MRSA as a primary pathogen.
  - Current approach probably not applicable and AHO should probably be treated more like chronic osteomyelitis

Acute Haematogenous Osteomyelitis

Prognosis

Adverse outcomes attributed to Acute Haematogenous Osteomyelitis

- Chronic Osteomyelitis
- Avascular Necrosis
- Growth Disturbances
- Deep Vein Thrombosis
- Pulmonary Embolism
- Multisystem Involvement
- Death

Herring J, Infections of the Musculoskeletal System, Tachdjians’s Pediatric Orthopaedics. 2014
Acute Haematogenous Osteomyelitis
Prognosis

Predictors of Poor Prognosis

- Younger age: Delays in diagnosis, presentation and treatment
- Location: Hip is at the highest risk of complications (40%), ankle (33%) and knee (10%)
- Concurrent Septic Arthritis, pyomyositis and/or abcess
- Virulence of Organism: MRSA (methicillin-resistant Staph. Aureus), PVL (Panton–Valentine leukocidin-positive Staph. Aureus), S Pneumonia
- Positive culture: Kingela Kingae frequently culture negative but also less virulent
- **Delay in treatment:** ‘Cure rate’ fall from 92% to 25% when treatment was delayed by > 5 days

Orthopaedic Emergency

Diagnostic Rate and Accuracy

AND

Effective Treatment

DETERMINE

Prognosis
Dankie
Thank you
Enkosi